GROUNDWATER CONDITIONS AT YOSEMITE WEST

prepared for
Yosemite West

by

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May 20, 1982

Mr. Dino Guaneli
Yosemite West
3621 Irlanda Way
San Jose, CA 95124

Dear Dino:

Enclosed are ten copies of my report on groundwater conditions at Yosemite West. Thanks for the extensive cooperation during this project.

Sincerely yours,

Ken Schmidt

Kenneth D. Schmidt

KDS:jc

Enclosures

CONCLUSIONS

1. Records on previous test hole and well drilling, construction of infiltration galleries, and well yields have been collected and interpreted. Wells have been plotted on a map and tables prepared showing construction data, well yields, and chemical quality of well water.

2. The three active supply wells and one active infiltration gallery tap only a small watershed, the upper part of the East Creek drainage. However, two additional supply wells and one infiltration gallery have been completed near the confluence of West and Indian Creeks, which is below a substantial drainage area.

3. Pump tests adequate to determine long-term well yields have been conducted on the two infiltration galleries and three of the wells at Yosemite West.

4. The most favorable location for future groundwater development is along the lower West Creek and lower Indian Creek drainages. It may be possible to develop an additional several hundred gpm on a long-term basis in this area.

5. Potential locations at intermediate elevations for groundwater development include the lower part of the East Creek drainage and along the West Creek drainage. It may be possible to develop an additional 20 to 30 gpm in the lower East Creek drainage and about 50 to 100 gpm along West Creek. The easterly part of the area along Indian Creek should also be explored.

6. A test drilling program is necessary in selected areas in order to develop additional groundwater.

7. For future production wells, special attention should be given to annular seals. Also, a very specific procedure should be followed for pump testing wells. The test drilling and pump testing program should be supervised by an experienced groundwater geologist or hydrologist.

GROUNDWATER CONDITIONS AT YOSEMITE WEST

The purpose of the investigation described in this report is to determine the potential for additional groundwater development at Yosemite West. The Yosemite West project site comprises 840 acres in Sections 22, 23, 24, 25, and 26 of T3S/R20E, about 12 miles north of Wawona. Well drilling at Yosemite West reportedly commenced in 1966 and Phariss and Simons (1973) described well drilling activities as of the end of 1972. Their water-resource evaluation delineated watersheds at the project site and included a map and table showing well data, locations, and the results of pump tests. Since that time, additional groundwater development activities have taken place. At least 23 wells and a number of additional test holes had been drilled and two infiltration galleries constructed at Yosemite West as of the end of 1981. Data available on these wells, including well yield, are discussed in this report. Areas most suitable for future groundwater development are delineated, potential recharge in specific areas is assessed, and potential well yields estimated.

Topography and Climate

Elevations of the land surface at Yosemite West range from about 4,500 to 6,200 feet about mean sea level. The project site is on the north flank of Henness Ridge and the land generally slopes to the northwest. Average annual precipitation is estimated to be about 45 inches per year, based on an isohyetal map prepared by the California Department of Water Resources for the period 1925-75. Most of the precipitation occurs in the

winter months, and snowfall is common from November to April. Runoff from the project site drains to Indian Creek, a tributary of the Merced River.

Surface Drainages

Phariss and Simons (1973) delineated sub-watersheds in the Indian Creek watershed. About 2,560 acres lie in the entire upper Indian Creek watershed, which includes the project site and upstream lands. Slightly less than 700 acres of this drainage are upstream of Highway 41. Phariss and Simons (1973) discussed two tributaries of Indian Creek that pass through the project site (Figure 1). East Creek heads near the water tank at the southeast corner of the project site, drains north through the meadow below the intersection of Henness Ridge and Henness Circle, and thence northerly to the confluence with Indian Creek. The East Creek watershed comprises about 80 acres, approximately 25 acres of which are in Yosemite National Park, east of the project site. West Creek heads near the southern part of the project site and drains to the northwest to the confluence with Indian Creek. The lowest elevations at the project site are near this confluence. The drainage area of the upper portion of this creek, which lies near or above the Phase I development, is about 240 acres. A relatively large tributary from the west joins West Creek just above the confluence with Indian Creek. The total watershed drained by West Creek, including this tributary, comprises about 830 acres. Slightly more than 700 acres of watershed are present along

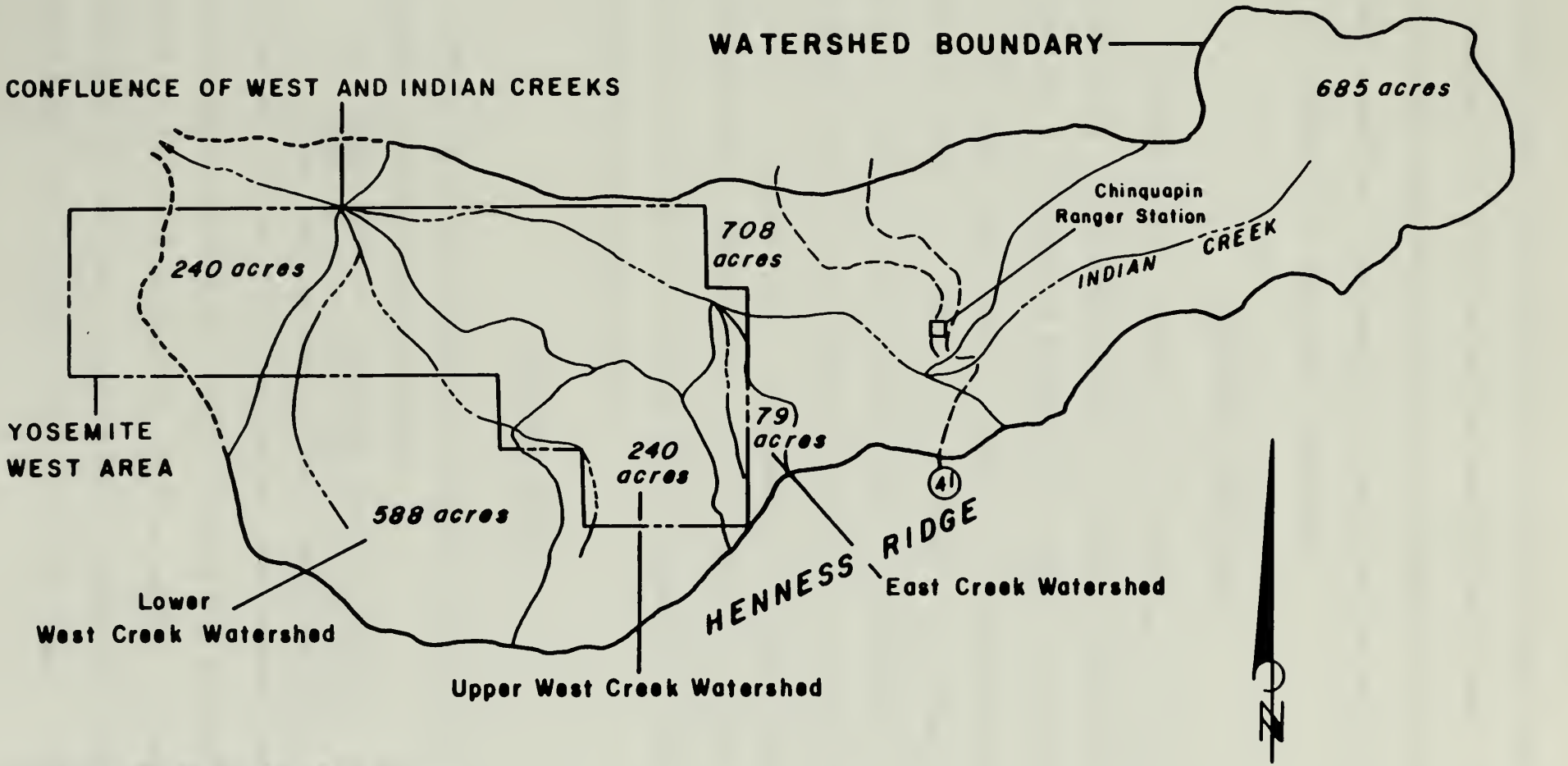


FIGURE 1 – LOCATION OF WATERSHEDS NEAR YOSEMITE WEST

Indian Creek between Highway 41 and the West Creek confluence, exclusive of the 80 acres drained by East Creek. The sizes of these sub-watersheds are crucial in terms of groundwater development, because they largely determine the potential recharge to groundwater in specific locations.

Geologic Conditions

Granitic rocks comprise the outcrops at Yosemite West. Groundwater is presented both in shallow weathered granitic rocks and in fractured hardrock at depth. The thickness of the weathered zone, based on data from existing wells, ranges from less than 5 to more than 50 feet, and probably averages about 30 feet, at the project site. Groundwater in the weathered zone can be tapped by radial or lateral wells and infiltration galleries. The character of the weathered materials and fractured hardrock mandate that groundwater can be successfully tapped by wells in only specific locations, not throughout the project site.

Project Wells

Past well drilling activities at the project site have centered on three primary areas:

1) Upper part of the East Creek drainage
2) Upper part of the West Creek drainage
3) Lower part of the Indian Creek drainage

Phariss and Simons (1973) reported that eleven vertical wells were drilled between 1966 and 1971 and one lateral well was completed in 1972. Attempts to drill a second lateral well were unsuccessful, however, infiltration galleries have been completed both along Indian Creek and East Creek. In addition,

more hardrock wells were drilled during 1972 and 1979-80. Plate 1 shows the locations of wells drilled at the project site. Drillers logs are available for most of the wells drilled at Yosemite West.

Meadow Area Along East Creek

Table 1 shows data for wells drilled in and downstream of the meadow area below Henness Ridge and Henness Circle. The three wells and infiltration gallery currently used for Yosemite West are in this locality. New Well No. 1 and Wells No. 2 and 5, all hardrock wells, and Well No. 4, the infiltration gallery, are now hooked into the Yosemite West System. Old Well No. 1, Well No. 2, and Well No. 3 (the lateral well) were used at various times prior to 1981. The drilling and pumping of new deeper wells has resulted in declining yields for older nearby shallower wells, which have thus been abandoned.

Area Above the Meadow

At least six hardrock wells were drilled in the area between the meadow and the water tank on the hill. Drillers logs are available for only two of these wells, and all of these wells reportedly yielded only several gpm or less, based on the airtests. This drilling has confirmed that conditions in this area are unfavorable for groundwater development.

Upper West Creek Area

At least five hardrock wells were drilled along or near the

TABLE 1 - DATA FOR WELLS ALONG EAST CREEK NEAR AND BELOW MEADOW

Well No.	Old No. 1	New No. 1	No. 2	Original No. 3	Present No. 3	No. 4	No. 5
Other No.	---	---	---	---	L-1	---	Well by Phonebooth
Location (Grid)	F-1	F-1	F-1	F-1	E-1	G-1	F-1
Type	Hardrock	Hardrock	Hardrock	Hardrock	Lateral	Gallery	Hardrock
Date Drilled	1966	8/80	Unknown	9/71	1972	1980	11/79
Driller	Unknown	Carrell	Unknown	Bannon	Johnson	---	Carrell
Depth (feet)	34	280	100	52	35	10-15	200
Depth Casing (feet)	Unknown	30	Unknown	13	12	---	50
Diameter Casing (inches)	---	7	---	7	42	---	8
Airtest (gpm)	35	45	10	40	---	---	8
Drillers Log Available	No	Yes	No	Yes	Yes	---	Yes
Long-Term Test	No	Yes	No	No	No	Yes	Yes
Status	Abandoned	Active	Active	Abandoned	Unused	Active	Active

Location of wells is shown in Plate 1.

upper part of West Creek, in the Choke Cherry area. In addition, an unsuccessful attempt was made to drill a lateral well (L-2) in this area. Table 2 shows data for wells in the Upper West Creek watershed. In general, yields of these hardrock wells were low, and not adequate for community wells.

Lower Indian Creek Drainage

At least five vertical wells were drilled along the lower part of the Inidan Creek Drainage. Four of these are hardrock wells, whereas the other apparently tapped highly weathered or unconsolidated materials to a depth of about 60 feet. In addition, an infiltration gallery was constructed just upstream of the confluence with West Creek. Table 3 shows data for wells along Indian Creek. The two relatively large yielding wells are also located near the confluence with West Creek.

Long-Term Yields

Air-tests at the time of drilling do not usually indicate the yields of wells under sustained pumping. Experience with wells tapping granitic rocks elsewhere in the Sierra Nevada has indicated that well yields often decline exponentially with pumping time (Schmidt, 1977). A procedure has been developed whereby long-term yields can be estimated based on pump tests of 10 to 15 days duration. This procedure was developed from the results of extensive pump testing of wells near Shaver Lake, northeast of Fresno, at elevations comparable to the project site. On the basis of trends in yield during the pump test,

TABLE 2 - DATA FOR WELLS IN THE UPPER WEST CREEK WATERSHED

Well No.	L-2	No. 4	No. 7	No. 8	Choke Cherry	Choke Cherry
Location (Grid)	A-10	---	F-11	C-10	A-10	A-10
Type	Lateral	Hardrock	Hardrock	Hardrock	Hardrock	Hardrock
Date Drilled	1973	9/71	9/71	9/71	5/72	5/72
Driller	Johnson	Bannon	Bannon	Bannon	Johnson	Johnson
Depth (feet)	---	129	102	128	97	97
Depth Casing (feet)	---	33	49	5	17	7
Diameter Casing (inches)	---	7	7	7	7	7
Airtest (gpm)	---	30	3	5	0.5	7
Drillers Log Available	---	Yes	Yes	Yes	Yes	Yes
Long-Term Test	---	No	No	No	No	No
Status	Not Completed	Abandoned	Abandoned	Abandoned	Abandoned	Unused

Location of wells is shown in Plate 1. The larger yielding well at Choke Cherry was reportedly used for a number of years to supply water for logging operations.

TABLE 3 - DATA FOR WELLS ALONG INDIAN CREEK

Well No.	Old No. 6	New No. 6	Old No. 9	New No. 9	No. 11	No. 2
Location (Grid)	R-26	R-22	R-13	R-25	R-26	R-22
Type	Hardrock	Hardrock	Hardrock	Hardrock	Vertical	Gallery
Date Drilled	9/71	9/80	9/71	9/80	1972	1977
Driller	Bannon	Carrell	Bannon	Carrell	Anderson	---
Depth (feet)	30	200	150	325	57	13
Depth Casing (feet)	3	80	5	80	57	---
Diameter Casing (inches)	7	7	7	7	8 & 12	---
Air Test (gpm)	0	0	2	105	22	---
Drillers Log Available	Yes	Yes	Yes	Yes	No	---
Long-Term Test	No	No	No	No	Yes	Yes
Status	Abandoned	Abandoned	Abandoned	Unused	Unused	Unused

Location of wells is shown in Plate 1.

the yield after 100 days of continuous pumping can be estimated. This period is a reasonable one to approximate water demand in the summer at sites such as Yosemite West. However, a careful procedure has to be followed in order to produce meaningful results. Part of this procedure is to pump the wells with the water level near the lowest water-bearing fracture or the bottom of the well.

Tests ranging from 10 to 11 days in duration have been conducted on the two infiltration galleries, New Well No. 1 and Well No. 5 in the East Creek Drainage, and Well No. 11 near the confluence of West and Indian Creeks. Although the yields after 10 or 11 days have been tabulated, the results had not been previously interpreted. Thus, as part of this study, yields for each well were plotted on a semi-logarithmic graph versus time since pumping began. Figures 2, 3, 4, and 5 are plots for the four pump tests conducted in September 1980 and Figure 6 is a plot for the test conducted in 1972. From these trends, the yield after 100 days of pumping at the maximum rate can be determined (Table 4). Under actual practice, a well should be pumped at a more uniform rate, and such rates are reported as long-term well yields in Table 4. Recovery measurements are not available for the 1980 tests, however more than one day of recovery measurements are available for the 1972 test. Figure 7 is a semi-logarithmic graph of recovery measurements for Well No. 11. Such information can be used to determine aquifer characteristics, knowledge of which is essential in evaluating groundwater conditions.

There are several limitations of the pump tests. Drillers

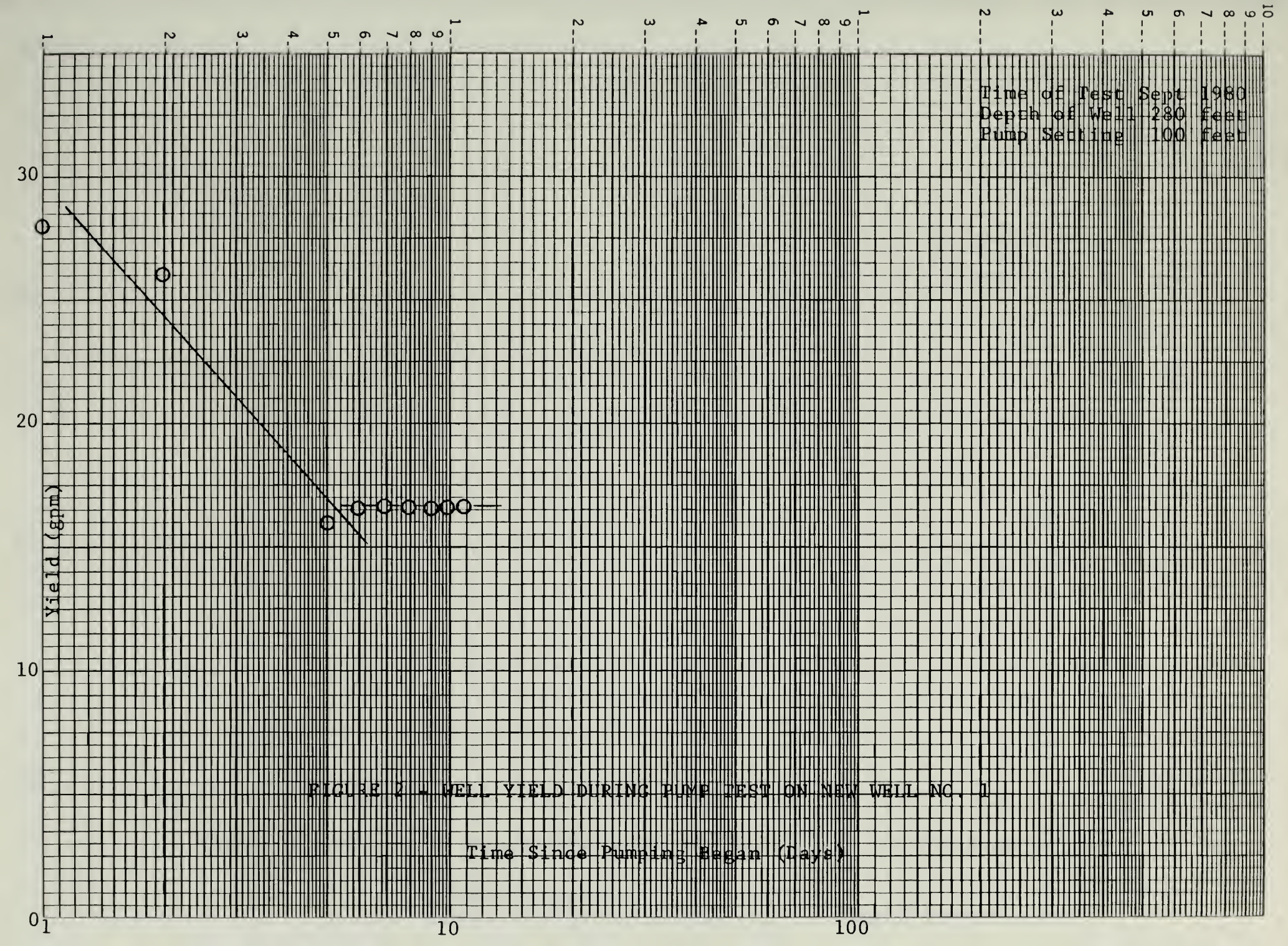


FIGURE 2 - WELL YIELD DURING PUMP TEST ON NEW WELL NO. 1

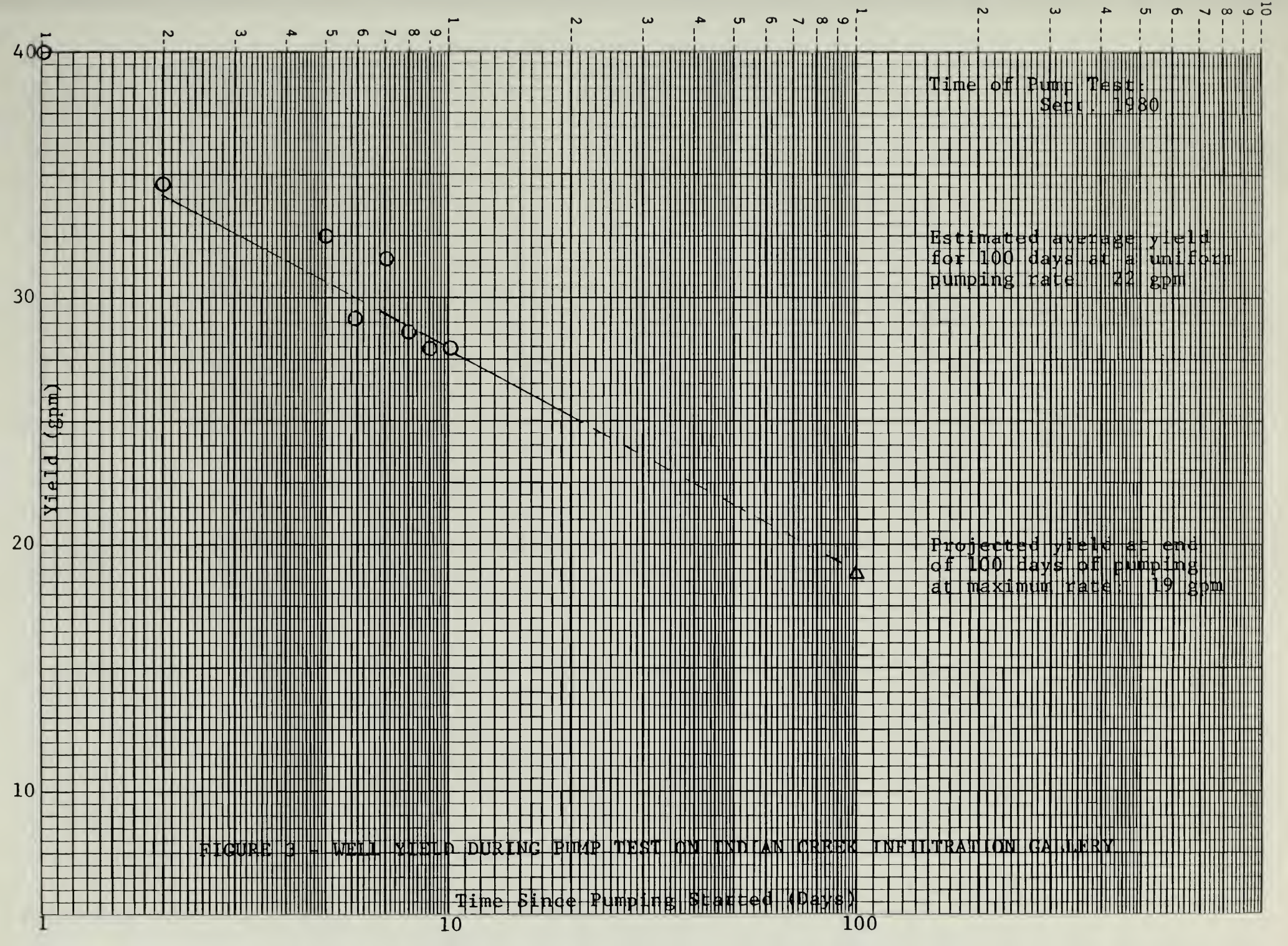


FIGURE 3 - WELL YIELD DURING PUMP TEST ON INDIAN CREEK INFILTRATION GALLERY

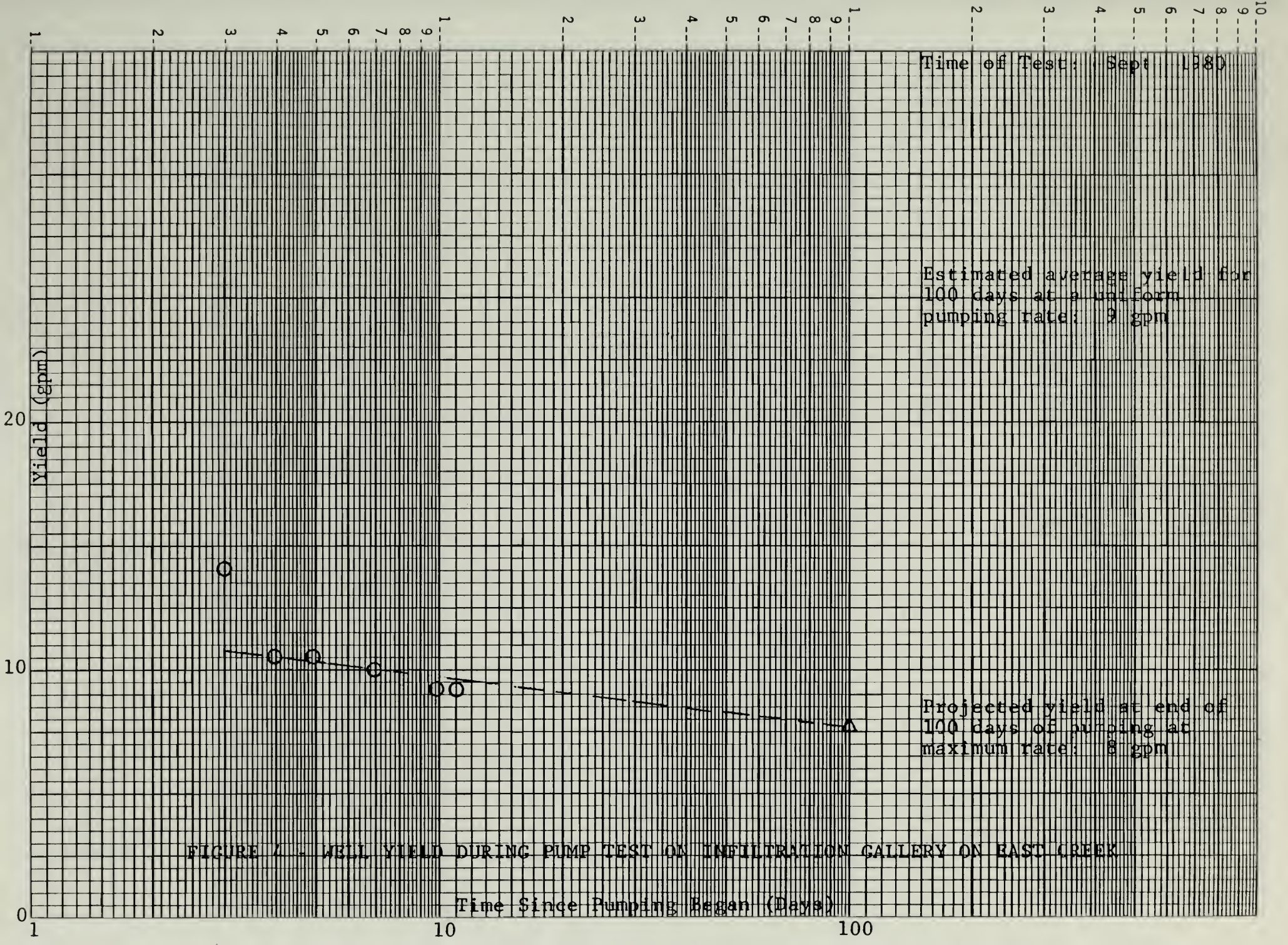


FIGURE 2 - WELL YIELD DURING PUMP TEST ON INFILTRATION GALLERY ON EAST CREEK

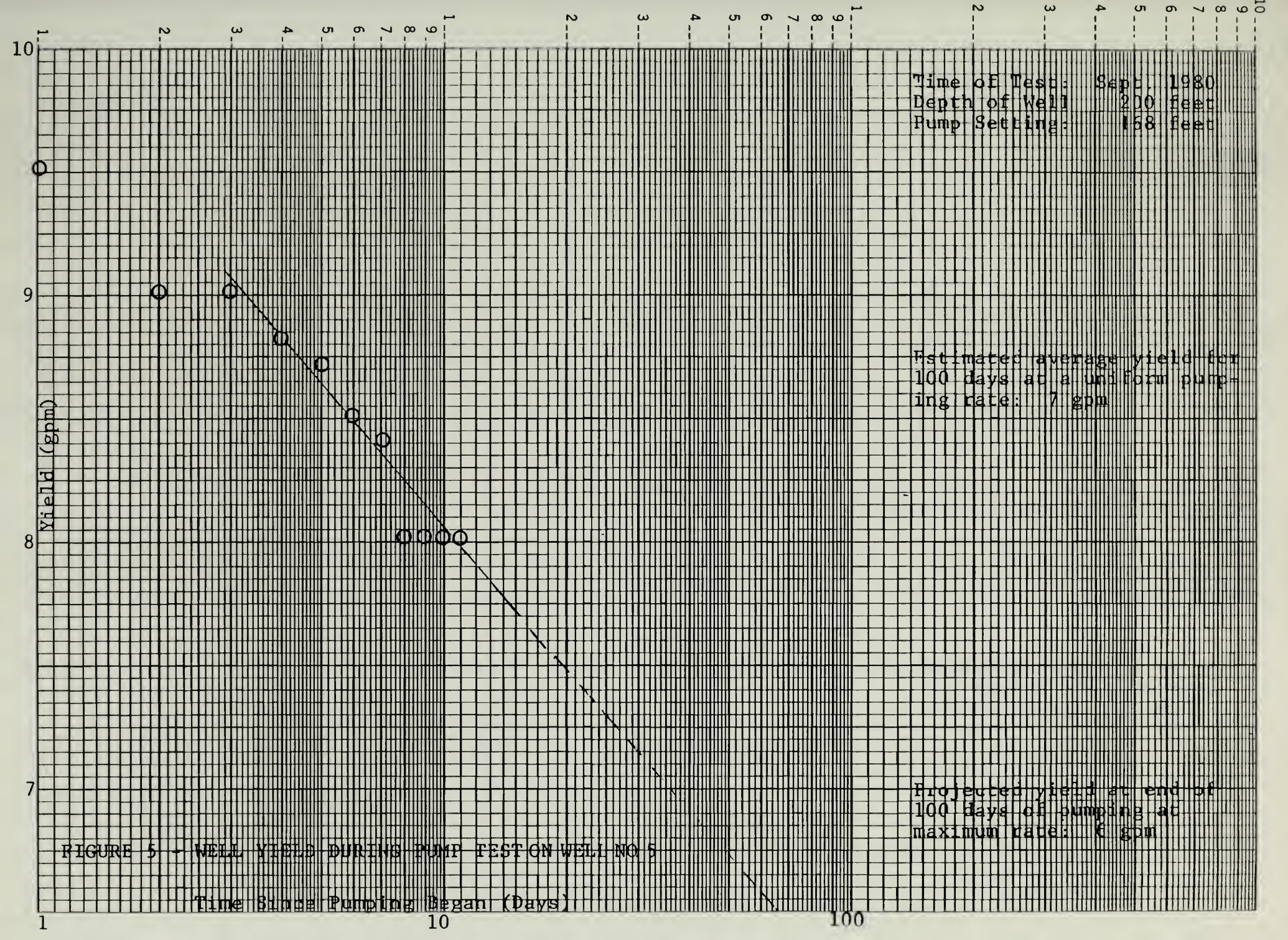


FIGURE 5 - WELL YIELD DURING PUMP TEST ON WELL NO 5

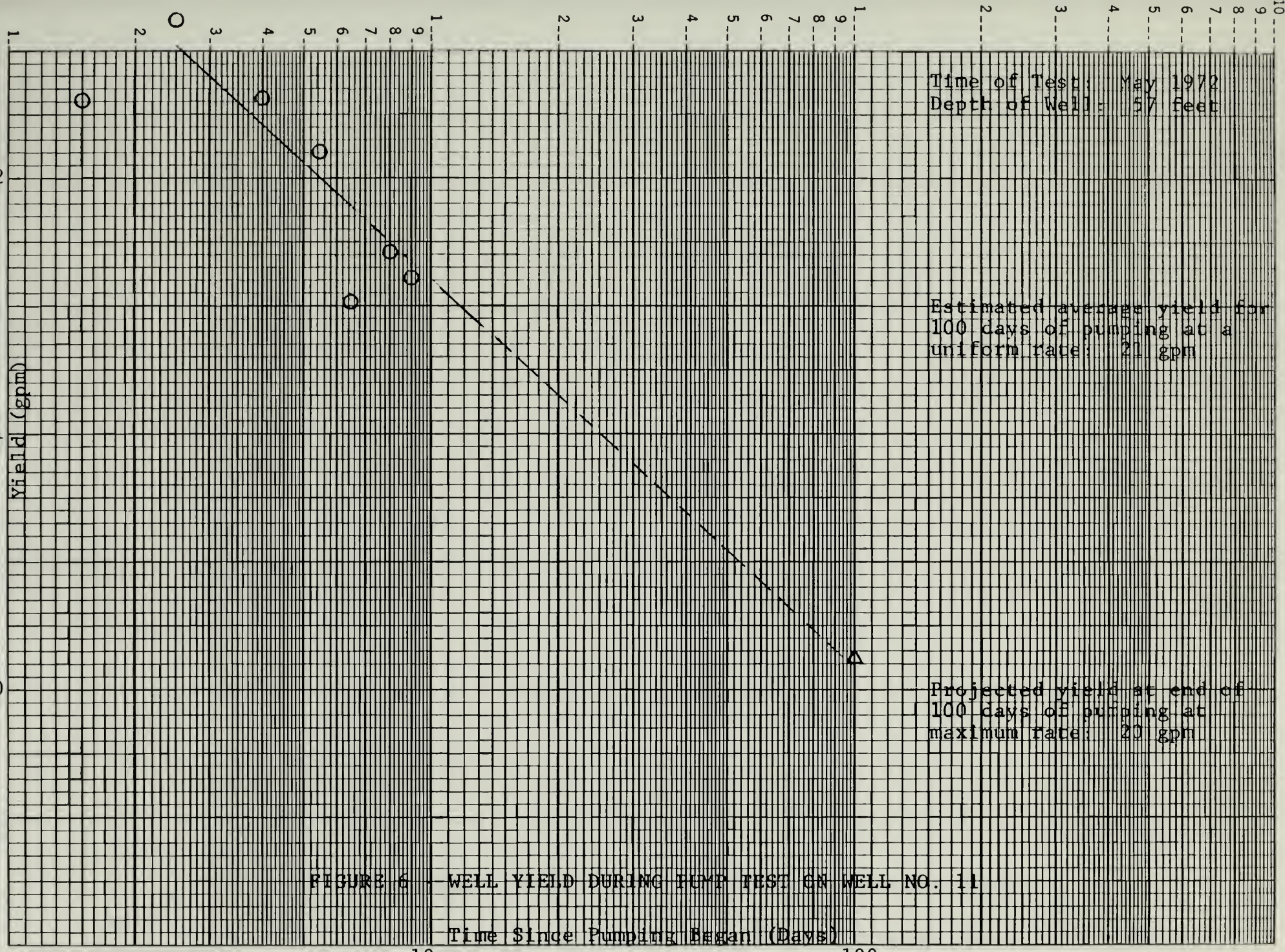


FIGURE 6 - WELL YIELD DURING PUMP TEST ON WELL NO. 11

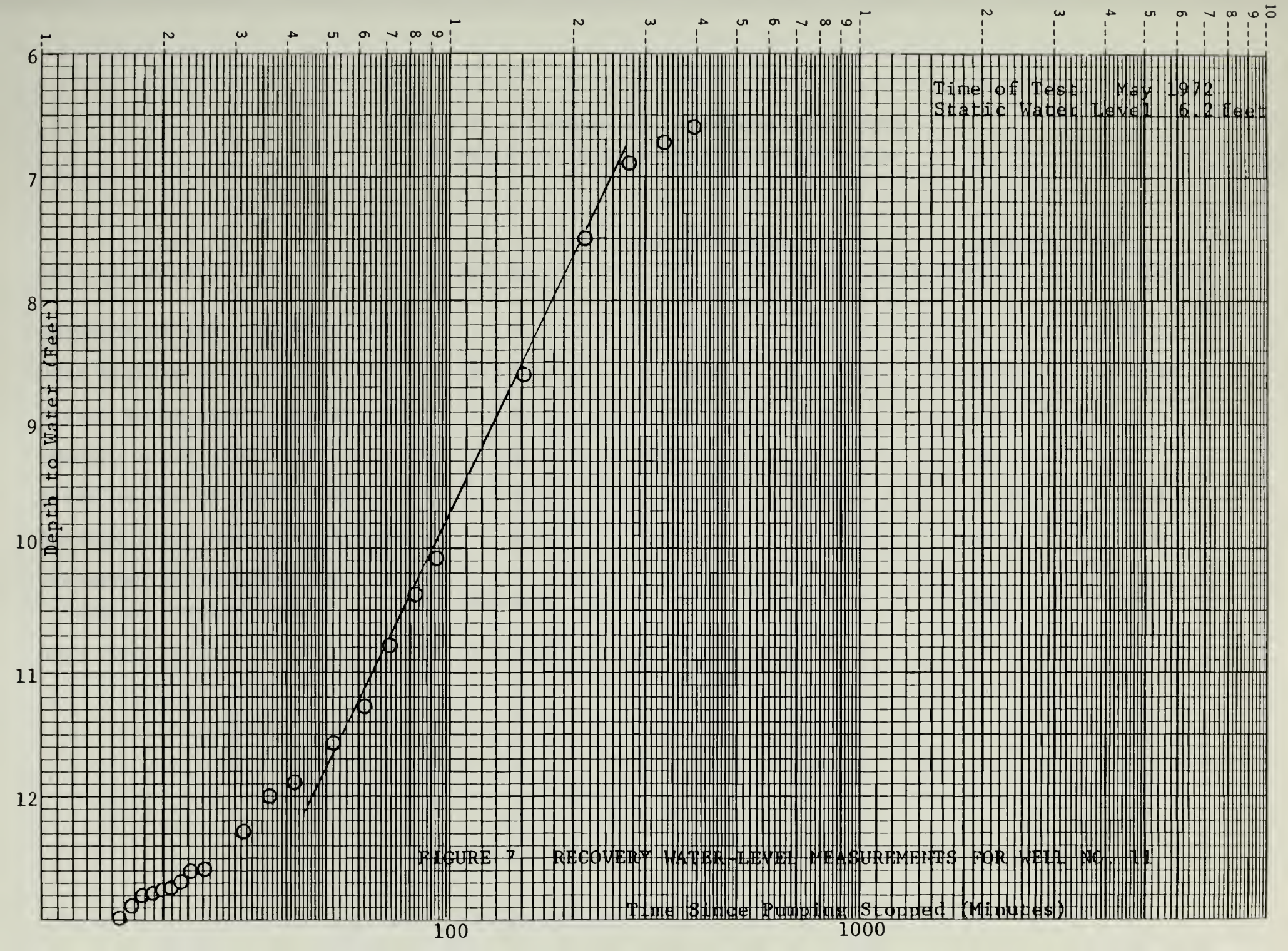


FIGURE 7 RECOVERY WATER-LEVEL MEASUREMENTS FOR WELL NO. 11

TABLE 4 - SUMMARY OF LONG-TERM PUMP TESTS
FOR WELLS AND GALLERIES AT YOSEMITE WEST

	East Creek Drainage			Indian Creek	
Well or Gallery	New No. 1	Well No. 5	No. 4 (Gallery)	No. 11	No. 2 (Gallery)
Duration of Test (days)	11	11	11	10	10
Date Started	9/11/80	9/11/80	9/11/80	5/14/72	9/12/80
Static Water Level (feet)	30	45	5	6	5
Pumping Level (feet)	50	145	15	40	11
Yield at End of Test (gpm)	16.5	7.7	9.0	20.6	27.8
Average Yield During Test (gpm)	15.2	Unknown	11.0	22.2	32.6
Projected Yield After 100 Days of Pumping (gpm)	Unknown	6	8	20	19
Long-Term Yield	Unknown	7	9	21	22

logs for wells at the site usually do not contain sufficient information on depths and yields of water-bearing fractures to allow a proper pump testing procedure to be established. The tests were not supervised by a hydrogeologist utilizing the standard procedures developed in Fresno County for such tests. The methodology of the tests has not been formally documented, including the following:

1) Accuracy of flow meters used to measure well yields.
2) Method and accuracy of devices used to measure depth to water.
3) Disposition of the pumped water.
4) Chemical and bacteriological analyses of pumped water.
5) Antecedent water level trends prior to pumpage.

In addition, no recovery measurements were made for 1980 tests, and these are absolutely necessary in order to determine aquifer characteristics and to evaluate long-term yields. The pump test procedure developed in Fresno County is based on drawing down the water level below the lowest major water-bearing fracture or near the bottom of the well, and trends in well yield are observed over the pumping period. The test for New Well No. 1 was not conducted in such a manner, and thus the long-term yield cannot be determined from the test.

Although groundwater was produced in the past from Old Well No. 1 and the lateral well in the meadow along East Creek, later wells were drilled in close proximity to these wells. According to operators of the Yosemite West System, the pumping of new deeper wells has reduced the yields of the shallow wells to such an extent that the shallower wells can no longer be effectively used. Thus, no separate yields are given in this report for the older shallower wells. Pump tests indicate that Wells No. 4 and 5 can produce 16 gpm on the long-term, whereas

the long-term yield of New Well No. 1 is probably between 5 and 20 gpm. The long-term yield of No. 2 has not been determined by pump testing, however, it apparently was capable of producing about 1 to 2 gpm in the late summer of 1980 and 1981.

As for other wells that may provide water on the long-term at Yosemite West, pump tests indicate that the infiltration gallery at Indian Creek can product 22 gpm and Well No. 11 was capable of 22 gpm in 1972. If Well No. 11 can be rehabilitated, it may still produce 22 gpm on the long-term. In addition, the hardrock well drilled near the confluence of West Creek and Indian Creek has yet to be tested, but has considerable potential for water production. However, this well is in close proximity to Well No. 11, and thus should be tested simultaneously with Well No. 11 if they are both proposed for use.

Chemical Quality

Table 5 contains the results of chemical analyses of water from two wells in 1972 and from the water supply system in June 1980. Manganese contents apparently exceeded the drinking water limit of 0.05 mg/l in water from Old Well No. 1 in 1972. This well was subsequently abandoned. Well water at Yosemite West is generally believed to be of excellent chemical quality at present.

Potential Recharge

Although pump tests provide an indication of how much water can be pumped from wells seasonally, the pumped water must be

TABLE 5 - CHEMICAL QUALITY OF WELL WATER
AT YOSEMITE WEST

Constituent (mg/l)	Old Well No. 1	Well No. 11	System
Calcium	3	5	3
Magnesium	<1	1	<1
Sodium	8	3	2
Carbonate	<1	0	<1
Bicarbonate	21	37	16
Sulfate	2	1	5
Chloride	4	4	<1
Nitrate	<1	<1	6
Iron	<0.01	0.02	<0.05
Manganese	0.2	0.02	<0.01
pH	7.4	6.8	7.6
Electrical Conductivity (micromhos/cm @ 180°C)	--	--	30
Total Dissolved Solids	37	41	18
Date	1972	1972	6/28/80
Lab	BSK	BSK	Cal Water Labs

replaced by recharge each winter in order to insure a long-term supply. Potential recharge is related to tributary watersheds above the well sites, because precipitation is the ultimate source of recharge. The area at the project site with the most potential recharge is near the confluence of West and Indian Creeks. An estimated 2,300 acres of tributary watershed lie above this location. Based on experience elsewhere in the Sierra Nevada in similar terrain, up to 1,000 acre-feet per year of water could be available for recharge. The limiting factor in groundwater development in this area is to construct wells of adequate yield to tap this recharge.

The area with the second most potential recharge is along Indian Creek upstream of West Creek, where an estimated 1,470 acres of tributary watershed are present. The area with the third most potential recharge is along the confluence of the two tributaries of West Creek, south of Indian Creek, where an estimated 830 acres of tributary watershed are present. The area with the fourth most potential recharge is in the upper part of the West Creek drainage, where 240 acres of tributary watershed are present. The area with the least potential recharge is the East Creek drainage, where less than 80 acres of tributary watershed are present.

Potential for Additional Development

Because of its small size and tributary watershed, the meadow area along East Creek is considered to be fully developed by the existing wells. However, additional groundwater may be

developed downstream of the infiltration gallery. It may be possible to develop an additional 20 to 30 gpm in this area. Only a few wells have been drilled in the West Creek watershed. Present information indicates that there is considerable potential to develop groundwater along West Creek, both near the confluence with Indian Creek and at an intermediate level between the upper part of the project site and the confluence. It may be possible to develop from 50 to 100 gpm in the upper West Creek watershed. Substantial potential to develop groundwater is present along the lower part of West Creek and along Indian Creek. Several hundred gpm or more could possibly be developed in this area. Substantial potential for development of radial wells may exist in this vicinity. The easterly part of Indian Creek at the project site should be carefully explored. No wells have been drilled in this area, which is at a relatively high elevation. A relatively large watershed is present above this area.

Recommendations

A test drilling program should be conducted in parts of the project site. There are three primary areas at moderate elevations where additional groundwater may be developed

1) Lower part of the East Creek drainage
2) Upper part of the West Creek drainage
3) Eastern part of Indian Creek

The most suitable location for development of groundwater from the hydrogeologic standpoint is near the confluence of West and Indian Creeks. However, before additional exploration is done

in this area, the existing hardrock well should be pump tested according to proper procedures. If the long-term yield of New Well No. 1 and Well No. 2 in the meadow area are desired to be known, then all of the three active wells in the vicinity should be re-tested simultaneously, following proper procedures. Test drilling should concentrate on areas near stream channels, and areas of high topography should be avoided. Depths of the test holes should be flexible, but a general guideline is about 300 to 400 feet near the confluence of West and Indian Creeks and about 200 feet in the areas of moderate elevation.

REFERENCES

Phariss, E.I., and M.C. Simons, 1973, "Water Resources Evaluation, Yosemite West Development, Mariposa County, California", 58 p.

Schmidt, K.D., 1977, "Hydrologic Monitoring Program at Fresno County Waterworks District 41 near Shaver Lake", report prepared for Fresno County Department of Public Works, 49 p.

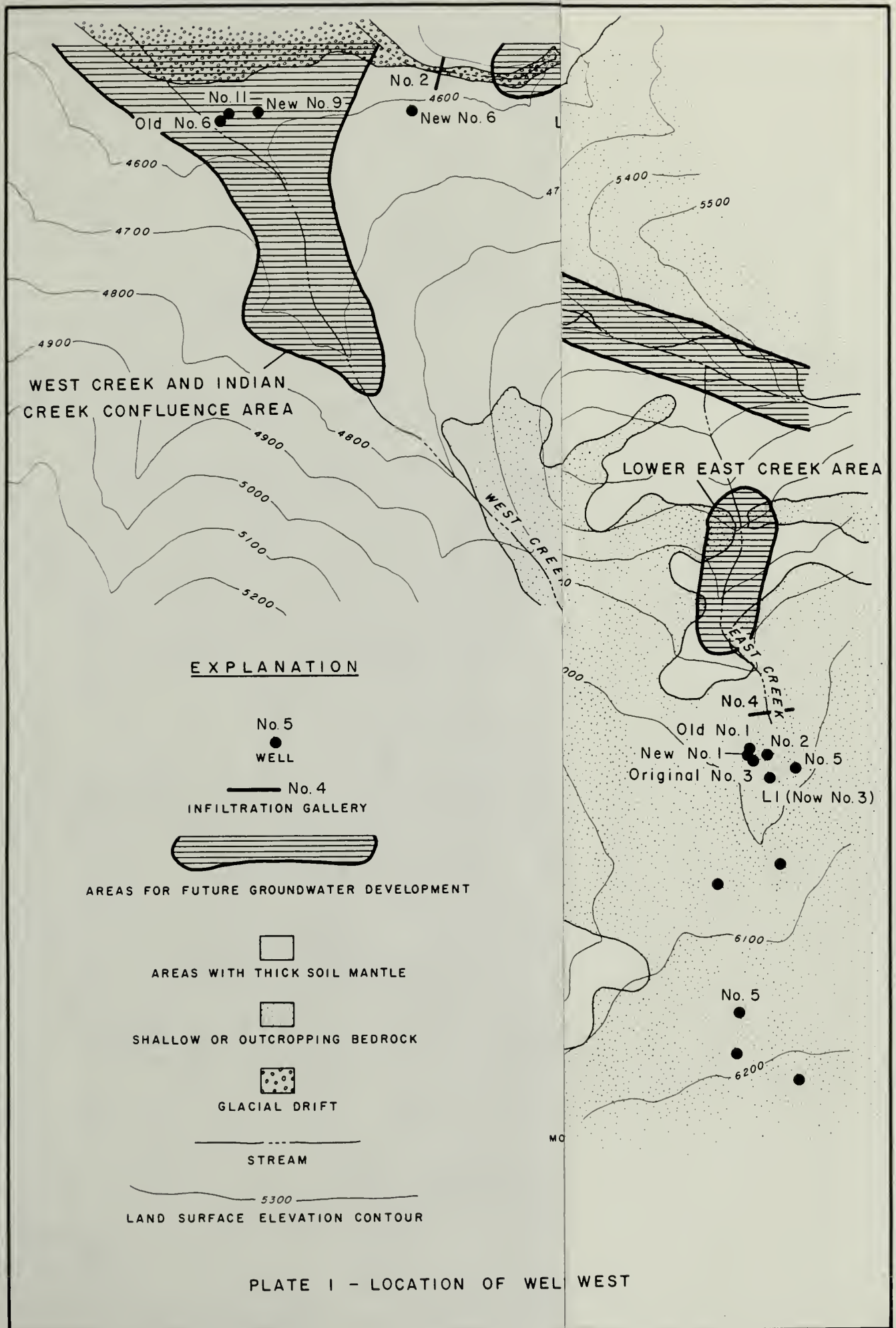
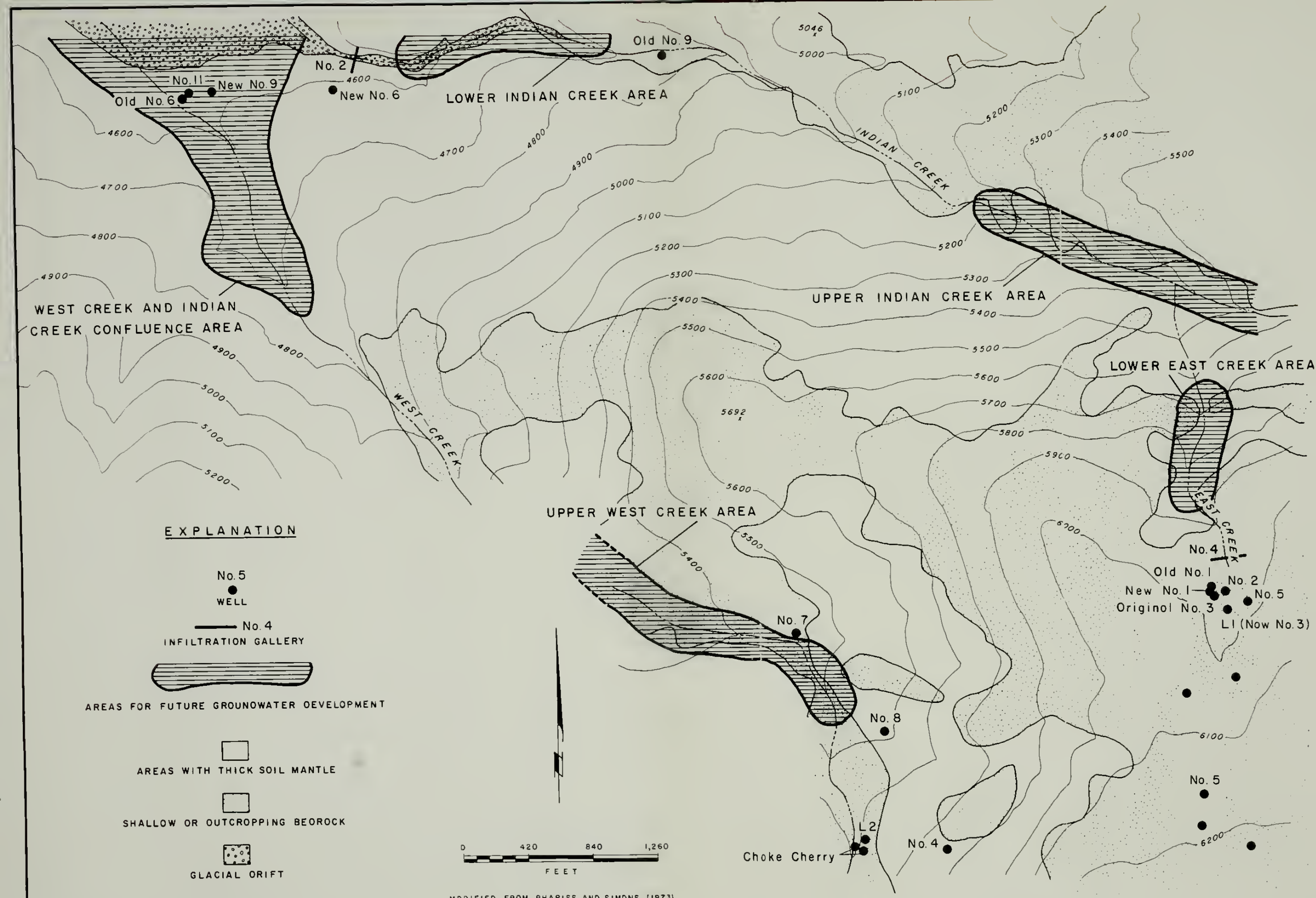


PLATE I - LOCATION OF WEL WEST



EXPLANATION

No. 5
WELL

No. 4
INFILTRATION GALLERY

AREAS FOR FUTURE GROUNOWATER OEVELOPMENT

AREAS WITH THICK SOIL MANTLE

SHALLOW OR OUTCROPPING BEOROCK

GLACIAL ORIFT

STREAM

5300
LANO SURFACE ELEVATION CONTOUR

0 420 840 1,260
FEET

MODIFIED FROM PHARISS AND SIMONS (1973)

K.D SCHMIDT APRIL 1982

PLATE I - LOCATION OF WELLS AND POTENTIAL AREAS FOR GROUNDWATER DEVELOPMENT AT YOSEMITE WEST